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Thünen and the New Economic Geography

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A lecture note prepared for the International Thünen Conference 2000, on the occasion of the 150th anniversary of Johann Heinrich von Thünen's death, the University of Rostock, September 21-24, 2000.

Abstract: In this lecture, first I briefly review Thünen's seminal theory on agricultural land use and rent, and discuss its contributions to modern urban economics. Next, I explain Thünen's equally pioneering, but less well-known work on industrial agglomeration. In my opinion, Thünen's thinking on industrial agglomeration was not only amazingly advanced at his time, but also it is new in several aspects even today. Finally, I show that if we unify Thünen's two pioneering works together using modern tools, then we inadvertently come up with a prototype model of New Economic Geography.

“Wherever economic theory is studied today, his ideas, his working methods, the problems he posed, have proved seminal right up to the present day—even there, where his name seems to have been forgotten, Thünen has worked. His work shines brighter than ever today. Much, which seems self-evident to us, goes back to him. And still not all the riches which are buried in his work are brought to light. To find them, you must without doubt read *The Isolated State* carefully and often.”(Erich Schneider, 1959, p. 27-8)¹

1 Introduction

About two centuries ago, Germany had two great scholars of young genius, Carl Friedrich Gauss (1777-1855) and Johann Heinrich von Thünen (1783-1850). Both were loners whose early works of genius were done in isolation in remote towns in Northern Germany (Gauss in Braunschweig, and Thünen in Holstein and later at his Tellow estate near Rostock). Both their works have provided our sciences with timeless impact: Gauss on mathematics and physics, while Thünen on economics and location theory. And yet (using Schneider’s words) not all the riches which are buried in their work have been brought to light. Furthermore, most importantly in my mind, both have been the fascinating humans with the most noble spirit and purest soul. Given that both their work and life have provided me with the guiding principles throughout my academic career, it is hard to express how deeply honored I am and grateful for this opportunity to speak on Thünen’s work at this International Conference on the occasion of the 150th anniversary of Johann Heinrich von Thünen’s death.

Depending on whether you are an economist or a geographer-location theorist, Thünen’s position in the history of sciences seems to be seen differently. In the words of a great economist Joseph Schumpeter (1954, p. 466), Thünen is “one of the patron saints of econometrics.” While, another great economist, Paul Samuelson

¹This quotation is from Schneider (1959) which was written to honour Thünen’s name on the 175th anniversary of his birth in 1958. The English translation quoted here is from the Introduction by Peter Hall to the English translation of von Thünen (1826) by Wartenberg (1966, p.xl.iv).

(1983, P.1468), states that “Among geographers and location theorists, Thünen is a founding God.” Well, either a patron saint or a god, we all agree that Thünen occupies a special position in the history of sciences.

According to Paul Samuelson in 1983 in his commemorative paper at the two-hundredth anniversary of Thünen’s birth, Thünen “not only created marginalism and managerial economics, but also elaborated one of the first models of general equilibrium and did so in terms of realistic econometric parameters.” (Samuelson, 1983, p.1468, emphases by the original author) More specifically, Samuelson asserts that “Thünen’s model has in it elements of all of the following systems:

1. The Ricardo–Torrens theory of comparative advantage.
2. The Malthus–West–Ricardo theory of rent.
3. The Hecksher–Ohlin and Stolper–Samuelson theory of factors–and–goods pricing.
4. The Marx–Dimitriev–Leontief–Sraffa system of input–output.” (p. 1481)

This is a praise so grand that no other economist in history, except possibly Adam Smith, could be bestowed with. Yet, whoever read Thünen’s original work would be ready to agree with Samuelson’s appraisal.

I also fully agree with Samuelson. However, as a location theorist myself, what I would like to emphasize today is that from the viewpoint of location theory, Thünen’s work contains more than that. That is, in addition to the four elements cited above by Samuelson, I would like to note that in his later work, Thünen also anticipates the following theories:

5. The Marshall–Weber theory of industrial agglomeration
6. The Christaller–Lösch theory of central place system
7. The Krugman theory of new economic geography

If you ask where we can find such pioneering ideas in Thünen's work, then I simply repeat Schneider's words quoted at the beginning of this lecture: "To find them, you must without doubt read *The Isolated State* carefully and often."

In short, Paul Samuelson has hailed Thünen's model as a "magnificent edifice" of **general equilibrium** which contains all the basic elements of modern competitive theory. As a founder of modern economics, Samuelson has naturally emphasized the generality of Thünen's contributions in economic analysis, while somewhat playing down Thünen's legacy to economic geography.

As a location theorist, however, today I would like to reclaim Thünen as the founding god of modern economic geography. Most mainstream economists have tended to play down the importance of geography or space in economic life by simply disregarding it as a messy nuisance. But then life is fundamentally messy, and this complexity is also the source of the richness and beauty of life. To see the beauty in the seemingly chaotic reality, however, we often need the eyes of a genius. When Thünen was just 20 years old, in his first paper—*Description of Agriculture in the Village of Gross-Flottbeck*, he had already glimpsed the idea of the so-called Thünen rings, an eternal gem of human intellect.

Thünen, however, was not an ordinary armchair scholar. Quite the opposite. As is well-known, he never occupied an academic position in his life. In fact, the initial idea of young Thünen has evolved to a grand theory of general equilibrium while he was working on his own Tellow estate, engaging in ceaseless agricultural improvement on his land. Thünen was satisfied with his abstract model only after taking laborious investigations of costs and returns on his Tellow estate over ten years, and then confirming that the collected data fitted directly into his model. No wonder, Schumpeter called Thünen "one of the patron saints of econometrics." In short, Thünen's timeless model of agricultural land use and rent has been "cultivated on land" literally while he was working as a farmer. As every one here knows well,

this part of his work on agricultural land use and rent was published as *The Isolated State* in 1826, later called Part I in order to separate it from later editions.

And, for a long time, I believed that from the viewpoint of geography and location theory, this was the end of the story. Of course, even if it were so, Thünen's story is already one of eternal scientific fascination. Then, just one month ago, a terrible shock came to me when I read Section 2 of the so-called Part II of *The Isolated State* for the first time in preparation for my presentation today (It was the Section 2 of the so-called Part II of *The Isolated State* edited by Hermann Schumacher and published in 1863, which contains Thünen's posthumous papers mainly dealing with the problems of spatial economy related to the original Part I.) Actually, I read only extracts of Section 2 because I am unable to read German, and only extracts are available in the English translation by Wartenberg (1966). If I borrow Schneider's words again, when I read the extracts, my amazement was just "even there, Thünen has worked"! "There" means no other than New Economic Geography.

In my opinion, Thünen is indeed the founding god of modern economic geography which includes not only traditional economic geography and location theory, but also the modern urban economics as well as the so-called New Economic Geography. In other words, Thünen was concerned not only with the working of the agricultural hinterland surrounding a single town, but also, at least in his later years, concerned with the working of the entire spatial economy including "the order and distribution of towns in the Isolated State" (which is the title of Extract 6 of Part 2, section 2).

In order to elaborate on this, it is useful to reconsider Thünen's work from the modern viewpoint of the self-organization of a complex system. As a farmer-soil engineer-agricultural reformer-location theorist-geographer-economist, Thünen was concerned with land. As all of us would agree, land is a fascinating subject of study with multifaceted characteristics. Land represents:

- i. a commodity used in production and consumption,

- ii. location providing an address for agents,
- iii. the field in which agents interact through market- and non-market systems,
- iv. the space in which geographical patterns and structures evolve,
- v. the domain in which culture breeds and history evolves, and
- vi. the sphere supporting the coexistence of all life, including the bacteria underground, weeds and plants on the surface, and all animals roaming on it.

The Islated State is a theory about the complex system on land in its entirety. Let us start with the most well-known part of it.

2 Thünen and the monocentric economy

If we want an example of how a great economist can use stark simplifications to get at the essence of an issue, it would be hard to beat the opening paragraph of The Isolated State:

IMAGINE a very large town, at the center of a fertile plain which is crossed by no navigable river or canal. Throughout the plain the soil is capable of cultivation and of the same fertility. Far from the town, the plain turns into an uncultivated wilderness which cuts off all communication between this State and the outside world.

There are no other towns on the plain. The central town must therefore supply the rural areas with all manufactured products, and in return it will obtain all its provisions from the surrounding countryside.

The mines that provide the State with salt and metals are near the central town which, as it is the only one, we shall in future call simply “the Town.”²

From this beginning, as is well-known, Thünen developed his classic model of the joint determination of land use and land rent in the agricultural hinterland surrounding the Town. He supposed that crops differ in both yield per acre and their transport

²This quotation is from the English translation of Thünen (1826) by Wartenberg (1966, p.7).

costs and allowed for the possibility that each crop could be produced with different intensities of cultivation. And he asked: How will the land be allocated if there is an unplanned competition among farmers and landowners, with each individual acting in his perceived self-interest?

Thünen showed that competition among the farmers will lead to the gradient of land rents that declines from a maximum at the town to zero at the outermost limit of cultivation. Each farmer is faced with a trade-off between land rents and transport costs. Since transport costs and yield differ among crops, a pattern of concentric rings of production will result. In equilibrium, the land-rent gradient must be such as to induce farmers to grow just enough of each crop to meet the demand, and this condition together with the condition that rents be zero for the outermost farmer fully determines the outcome.³

Figure 1 illustrates schematically the typical outcome of a Thünen model. (For those of you in this conference, I am sure, no explanation of this figure is necessary. None the less, let me say a few words about it.)

Figure 1:

In the upper part of the figure, each straight line represents the **bid rent curve** of the corresponding crop,⁴ the rent that farmers raising that crop would be willing to pay at each distance from the town. Since the competition among farmers makes all the surplus from growing a crop at any distance accrue to landowners, each bid rent curve is equal to the surplus (net of all costs except land rent) per unit of land from growing that crop at each distance from the town. The heavy line, the envelope of the bit-rent curves, defines the **market rent curve** in equilibrium. Since each location

³For early contributions to a systematic treatment of Thünen's ideas in fully mathematical form, see Laundhardt (1885, ch.30), Lösch (1940, ch5) and Dunn (1954).

⁴The term, bid rent curve, was first introduced by Alonso (1964) in order to distinguish it from the market (or, realized) rent curve.

is occupied by the crop that offers the highest bid rent, concentric rings of cultivation emerge, as shown in the lower part of the figure.

Thünen's model may now seem quite simple and obvious, but it embodies actually ingenious and profound analyses of the spatial economy.(Fujita, Krugman and Venables, 1999, pp.16-18). In particular, it is a striking example of the power of economic modeling to generate unexpected results. After all, determining which crops to grow where is not that easy. By allocating an acre of land near the Town to some crop, you indirectly affect the costs of delivering all other crops, because you force them to be grown further away. Furthermore, in Thünen's original model in *The Isolated State*, the wage of farmers at each distance from the Town is to be endogenously determined such that the utility of farmers, who consume crops grown in the field as well as goods manufactured at the Town, is the same everywhere.⁵ Except in the case where there is no possibility of substitution of inputs in crop production and goods in farmers' consumption, it is by no means trivial to determine which crops will be grown where. Yet Thünen's analysis shows us that there is a clear answer to what will happen: the spontaneous emergence of a concentric ring pattern. Indeed, the concentric rings will emerge even if no farmer knows what anyone else is growing, so that nobody is aware that the rings are there. Moreover, it turns out that this unplanned outcome is socially efficient.⁶ It represents the working of Adam Smith's invisible hand at its best.

Despite its significance as a monumental contribution to scientific thought, Thünen's theory languished without attracting the widespread attention of economists for over a century. The reason for such a historical misfortune may be partly explained by the so-called the "Anglo-Saxon bias" against spatial analyses (Isard, 1956). Ironi-

⁵This aspect of wage determination of farmers has been completely neglected in almost all subsequent variations of Thünen's model except in the recent general equilibrium analyses by Samuelson (1983) and Nerlove and Sadka (1991).

⁶That is, the total combined cost (excluding land rent) of producing and shipping the equilibrium consumption of crops at the Town is minimized.

cally, Thünen’s theory of spatial economy which originated in an agricultural context was eventually appreciated and flourished only after it was reborn as an urban spatial model in the 1960s.⁷

At the time of Thünen and even long after that, the economy was dominated by agriculture, and hence little attention was paid on cities. However, in the mid-20th century, an explosive growth of urban population started in many countries. The resulting rise in urban problems has manifested an urgent need for a comprehensive theory of modern urban economies. Given that urban problems are predominantly of spatial issues, many economists and geographers have naturally refocused their attention to the seminal work of Thünen. In particular, Alonso (1964) reinterpreted the monocentric economy model of Thünen by substituting commuters for farmers and the central business district (CBD) for the Town, and generalized Thünen’s central concept of bid rent curves to an urban context.⁸ This “monocentric city model” provided modern urban economics with the theoretical foundation.⁹ Since then, urban economics has advanced rapidly, culminating in the development of the so-called “New Urban Economics ” in the early 1970s. As is well known, it remains to this day the basis for an extensive theoretical and empirical literature.¹⁰

Such versatility of Thünen’s spatial theory stems from the transparency and generality of its theoretical basis. Although Thünen’s original model of monocentric economy is actually a very complex general equilibrium model, its essential assump-

⁷For a systematic discussion of this rebirth of Thünen’s model, see Baumont and Huriot (2000).

⁸Alonso’s work was preceded by the pioneering work of Isard (1956), Beckmann (1957) and Wingo (1961).

⁹The monocentric city model yielded, not surprisingly, essentially the same results with Thünen’s model, including the concentric rings of land use depending on the characteristics of households such as income level, value of time, and family structure.

¹⁰Prominent among the efforts in this area are the works of Muth (1969), Mills (1967, 1972) Casetti (1971), Solow (1973), Henderson (1977), Kanemoto (1980), and Miyao (1981), to name a few. Much of this literature is concerned with determining the rent curve and the pattern of land use when labor and capital may be substituted for land in the production of housing and other services. There have also been extensive investigations of the implications of congestion, of the use of land for roads, neighborhood externalities, and other issues. A detailed examination of these issues may be found in Fujita (1989), and Papageorgiou and Pines (1999).

tions can be summarized, using modern terminology, into the following three:¹¹

- A1. The location of markets for the final products is exogenously given.¹²
- A2. The production technology in each sector exhibits constant returns to scale with diminishing marginal products.
- A3. All product-and-factor markets are perfectly competitive (so that every agent takes all prices as given).

The first assumption is about the geographical structure of the economy while the remaining two coincide with the basic assumptions of neoclassical economics.¹³ As long as the three basic assumptions are maintained, Thünen’s model can be applied in a great variety of contexts, as exemplified in modern urban economics.¹⁴

Yet Thünen-type models have an important limitation: Although they give a beautifully clear explanation of land use surrounding a town (or land use within an metropolitan area surrounding a CBD), they simply assume the existence of the town or the CBD itself. This does not make for a bad model, but it does make for limited one. If our question is not simply how land use is determined given a preexisting town, but how and where the town or towns (or, the CBD or CBDs) emerge and what is the resulting spatial structure of the entire economy, then Thünen’s model offers little help. This is clear from Assumption 1 which in effect specifies exogenously the basic spatial structure of the economy.

¹¹Hereon, we take another basic assumption of Thünen, “farming is conducted absolutely rationally,” as granted.

¹²Although there is only a single marketplace in the original model of Thünen, there can be more than one. In fact, in Part II of Wartenberg (1966), Thünen himself considers an economy with many towns. The essential assumption is that their locations are exogenously specified.

¹³The marginal cost pricing of production factors, a great contribution of Thünen, naturally comes out from A2 and A3.

¹⁴Thünen, of course, knew this point. In fact, in a short passage (Thünen 1826, English translation, p.133) where Thünen briefly discusses about the land rent in the town or the “ground rent” to distinguish it from the “land rent” in the agricultural area, he simply states that “for one and the same law governs ground as well as land rent”.

Urban economists have, of course, soon realized this limitation. Thus in practice, they have often supplemented a Thünen-type model with some ad hoc assumptions (often appealing to a vague concept of external economies) in order to justify Assumption 1. It is obvious, however, that in order to endogenously determine the entire spatial structure of an economy (or, the entire metropolitan area), this assumption must be abandoned.

An easy way to drop Assumption 1 is to replace it with another assumption which appeals to the locational difference in “first nature” such as differential soil conditions or the existence of navigable rivers and natural ports. This approach is, however, directly against the original spirit of Thünen, which is clearly stated in the opening paragraph of *The Isolated State*: he intended to eliminate the influence of first nature in order to develop a pure theory of land use and land rent.¹⁵

It turned out that a more satisfactory and fruitful way is to drop Assumption 1 entirely, and to explain the formation of the entire spatial structure of the economy (including the formation of a town or towns, or a CBD or CBDs) purely endogenously.¹⁶ This is the approach taken in the so-called New Economic Geography which emerged in the late 1980s.

In developing this approach, the crucial question is how to explain the *endogenous* forces of agglomeration which lead to the formation of towns or CBDs. Surprisingly, however, this question was already investigated systematically by Thünen himself more than one and a half century ago, as I will explain in the next section.

¹⁵In the last part of the opening paragraph, Thünen assumes that mines are near the town, which provide the State with salt and metals. This assumption, I believe, was introduced not to justify the formation of the town at a particular location but to preempt an expected question at his time. Indeed, when Thünen discusses the distribution of towns in Part II, he assumes in effect that mines for salt and metals can be developed anywhere in the State.

¹⁶As explained later, however, this approach turns out to be theoretically not easy, for the three basic assumptions of Thünen’s model are so tightly connected to each other that if we drop A1, then the other two also must be given up.

3 Thünen and agglomeration economies

When we discuss about the reasons for the concentration of an industry (or industries) at a specific location, or more generally, the agglomeration of people and industries in a city (or in a system of cities), it has been a custom to go back as far as to Marshall (1890,1920, ch.x), and then to Weber (1921) and Hoover (1936), and to the central place theory of Christaller (1933) and Lösch (1940). To the best of my knowledge, there is no article in economics literature which associates the topic of agglomeration (or distribution of cities) with Thünen.¹⁷ Location theorists and economic geographers (both “traditional” and “new”) always referred to Thünen, but never in the context of agglomeration economies or city formation. Thus, it is a great surprise to realize that (using Schneider’s words again) “even there, where his name seems to have been forgotten, Thünen has worked”!

To see where Thünen has worked, it may be sufficient to glance over the following contents of Part II, Section 2 of the English translation (Wartenberg, 1963), which contains the extracts of posthumous papers on location theory written by Thünen between 1826 and 1842.¹⁸

Part II
SECTION TWO
(Extracts)



5. Changes in our assumptions (many towns of the same size equi-distant from each other)
6. The order and distribution of towns in the Isolated State
7. The role of population density
8. The dynamics of the Isolated State: are there obstacles to its expansion?

¹⁷This excludes, of course, the overall introduction of *The Isolate State* by Peter Hall in the English translation by Wartenberg (1966).

¹⁸The titles of subsections 1 to 4 are omitted here since they are not related to the present topic of agglomeration.

Given that I had access only to the extracts of Thünen’s work in this part, I must be careful with what I say here. Nevertheless, let me briefly discuss it with an emphasis on Subsection 6. As we all know, in Part I, Thünen assumed that the Isolated State contained only a single large town. In contrast, in Subsection 5 here, Thünen assumes that the plain contains many small towns of the same size located equidistantly from each other, and investigates how the size of towns and the distance between them affect the pattern of agricultural production and land rent. This subsection is somewhat a precursor of the central place theory of Christaller(1933) and Lösch (1940). However, in this subsection, Thünen does not discuss how the size of each city is determined nor how the distance between cities is decided, which are the main topics in the next subsection.

In Subsection 6, Thünen asks “What determines the relative position of the towns in the Isolated State in respect of size and distance from each other?”(p.285)¹⁹In studying this fundamental problem, Thünen further divides the problem into a number of more concrete questions.

The first question is about the concentration of people in large towns such as the Capital. If the (urban) population of the economy were divided among many small towns, then every consumer would be easily accessible to agricultural supply. Thus, Thünen asks:

“Why then is the population of the large Town not divided among many small ones? The reasons are as follows:

1. In practice, deposits of ore, salt and coal are most unevenly distributed....
2. The focal centre of a country is the natural residence of the head of the government;the seat of the highest offices of justice and administration, of army head quarters, the higher institutes of learning, art collections, etc.
3. The presence of the capital of the court, the concourse of scholars, men of science and state officials, the theaters, museums, etc., afford many more social attractions and amenities than the provinces could ever offer...

¹⁹Each quotation below without the author’s name is from the English translation by Wartenberg(1966).

4. To cater for the needs and pleasures of all the citizens assembled in the capital for any of these reasons, a great many people of the artisan and service class are required...”(p.286)

In terms of modern urban economics, the first reason refers to first nature, the second to central management functions and public service, the third to social and cultural amenities, and the last to nontradable consumer goods and services. It is interesting to note that if the natural amenities were included in the first factor, then all four factors above have been increasingly emphasized recently as important determinants of population agglomeration in future cities(e.g., Glaeser, 2000). Notice, however, that when Thünen asks the reasons for agglomeration of people in a large town, he does not consider those reasons for the agglomeration of industries and their workers. This is the question he inquires next:

“Of far greater importance and difficulty is the question:whether industries which draw their raw materials from, and sell most of their products to, the provinces, are also better off located in the capital?”(p.286)

In investigating this question, first he asks the reasons against the location of industries in the capital, or the **centrifugal forces** (using the terminology of the New Economic Geography) against industrial agglomeration. Thünen’s answer is:

- “1. Raw materials are more expensive than in the country towns on account of the higher cost of transport.
2. Manufactured articles incur the cost of haulage to the provincial towns when they are distributed to the rural consumers.
3. All necessities, especially firewood, are much more expensive in the large town. So is rent for flats and houses, for two reasons (1) construction costs are higher because raw materials have to be brought from a distance and are consequently more expensive, and (2) sites that may be bought for a few thalers in a small town are very dear.

Since food, as well as fuel and housing, cost so much more in the large town, the wage expressed in money, must be much higher than in the small one. This adds appreciably to production costs.”(pp.286-7)

The consideration of centrifugal forces above is surprisingly comprehensive even in comparison with the recent literature of New Economic Geography. In particular,

the effects of high land rents and high food prices on monetary wages in large towns are explicitly considered.

Next, Thünen investigates in depth the centripetal forces of industrial agglomeration:

“The following factors, on the other hand, favour the location of industries in large towns:

1. Only in large-scale industrial plants is it profitable to install labour-saving machinery and equipment, which economise on manual labour and make for cheaper and more efficient production.
2. The scale of an industrial plant depends on the demand for its products.
3. The number of buyers depends, in provincial towns, on the number of countrymen coming in to sell their products, or passing through on their way to the capital.

For instance, a countryman may visit the capital to sell his products, and decide to buy some liquor. It will be cheaper for him to buy this in the capital, even if it costs him half a thaler more than he would pay in the provincial town two miles from his farm, because he would have to make a special journey to fetch the local alcohol.”

- “4. For all these reasons, large scale plants are viable only in the capital in many branches of industry. But the division of labour (and Adam Smith has shown the immense influence this has on the size of the labour product and on economies of production) is closely connected with the scale of an industrial plant. This explains why, quite regardless of economies of machine-production, the labour product per head is far higher in large than in small factories.”(pp.287-88)

Turning to the nature of labor-and-product markets in large towns, Thünen continues:

- “5. People aware of possessing an exceptional skill or talent will not wish to waste their time on other work, where they can achieve nothing outstanding, but will move to the capital, to devote all their energy to their particular skill; in return they will reap ample reward.

Thus the capital attracts outstanding talents—among business men, artisans and labourers as well as among scholars and civil servants—and in this way is able to obtain a significant advantage over the provinces.

6. The large town offers buyers and sellers far more guarantee of being able to buy and sell at current prices.

The great merchant has not the time to consider the special situation of his customer and fix the price of the article he wants to sell according to the buyer’s needs or knowledge. He has an established price; which protects the customer from sharp practice. Besides, in the presence of so many competitors the attempt to cheat the customer would be scarcely worth the trouble”(p.288)

Finally, Thünen considers the linkage or “association” among industries:

- “7. Where factories and workshops employ machinery and equipment that has been produced in the large town and is incapable of being locally repaired, each repair will cost much in transport, and will give rise to considerable and harmful delays in production

Since it takes machines to produce machines, and these are themselves the product of many different factories and workshops, machinery is produced efficiently only in a place where factories and workshops are close enough together to help each other work in unison, i.e. in large towns.

Economic theory has failed to adequately appreciate this factor. Yet it is this which explains why factories are generally found communally, why, even when in all other respects conditions appear suitable, those set up by themselves, in isolated places, so often come to grief. Technical innovations are continually increasing the complexity of machinery; and the more complicated the machines, the more the factor of association will enter into operation.” (pp.289-90)

Thünen’s answer above to the question of centripetal forces (towards the industrial agglomeration in large towns) is truly amazing for three reasons. First, when Thünen wrote the article on this topic, Germany (in particular, Tellow area) was before experiencing the Industrial Revolution, thus industries in most German cities were quite primitive. Hence, for a farmer-scholar at his Tellow estate in isolation, this writing represents an amazingly imaginative work based solely on his insights. Second, however, Thünen’s explanation above is so systematic and comprehensive that it could become a good base for writing on agglomeration economies in a modern textbook. Finally, yet, few scholars seem to have paid attention to this truly pioneering work.

In his influential monograph, *Geography and Trade*, which marked the birth of the New Economic Geography, Paul Krugman states as follows (1991b, pp.14-15):

“The basic story of geographic concentration that I will propose here relies on the interaction of increasing returns, transportation costs, and demand. Given sufficiently strong economies of scale, each manufacture wants to serve the national market from a single location. To minimize transportation costs, she chooses a location with large local demand. But local demand will be large precisely where the majority of manufacturers choose to locate. Thus there is a circularity that tends to keep a manufacturing belt in existence once it is established.”

Notice that when Thünen’s first four agglomeration factors are combined, it coincides almost exactly with the above Krugman’s “basic story” for the emergence of a core-periphery structure on a nationwide scale.²⁰ Furthermore, if we combine the first

²⁰To be precise, of course, there exist some differences. In particular, Krugman is explicit in emphasizing the circular causality between the agglomeration of industries and the agglomeration of workers through demand externalities. But, Thünen is not explicit about this circular causality.

four factors of Thünen with his last (7th) agglomeration factor, which concerns the inter-industry linkage or “association”, then it now agrees with another basic story of New Economic Geography which explains the **localization** of particular industries both internationally and intranationally.²¹

Moreover, Thünen’s fifth factor, which concerns the self-selecting migration process and the impact of the size of labor market on **job-matching** among heterogeneous workers, has just recently started being modeled in New Economic Geography using a game theoretic approach (Helsley and Strange 1990, and Hamilton, Thisse and Zenou 2000). The same note applies to the part of Thünen’s fourth factor of agglomeration which refers to the **intra-industry specialization** in cities (see, for example, Becker and Henderson, 2000). Likewise, in the third factor of agglomeration, Thünen mentions, in effect, **joint-trips** as an important cause of industrial agglomeration in large towns, which has not been explicitly modeled yet in the New Economic Geography. Last, Thünen’s sixth factor of agglomeration refers to two separate effects of market size : (i) more competitors (in an industry) in a town will lead to lower prices, hence benefitting buyers, and (ii) the pooling-effects of a larger market will lead to more stable prices, benefitting both sellers and buyers. Although the first effect is well considered in New Economic Geography, the second one is not explicitly modeled yet. Therefore, we can conclude that Thünen’s thinking about industrial agglomeration was not only quite advanced at his time, but also it is new in several aspects even today.

Finally, it is interesting to compare Thünen and Marshall on industrial agglomeration. It is well-known that Marshall (1890, 1920, Ch.x) introduced the trinity of the so-called Marshallian external economies: (i) linkages, (ii) thick markets, (iii) knowledge spillover and other pure external economies. Among the three lo-

This may reflect the primitive stage of manufacturing in Germany before the Industrial Revolution, where such demand externalities are weak because of small expenditure-share of workers’ income on manufactures.

²¹For a recent exposition on industrial clustering, see, for example, Fujita et. al. (1999, Part III), and Fujita and Thisse (2001, Ch 9 and 10).

calization forces of Marshall, Thünen never mentioned the third. We can conjecture several different reasons for this, but there is no way to know the real one. In this respect, it may be noted that in the recent our book, *The Spatial Economy* (Fujita, et.al., 1999), we also did not touch the third force of Marshall. This is because we do not have a good micro-foundation of knowledge externalities yet. In this respect, as a general equilibrium theorist, Thünen has been closer to today's New Economic Geography than Marshall. (About Subsections 7 & 8 of Section Two, Part II of Thünen, I will discuss later.)

4 Thünen uni...ed–the New Economic Geography

Incidentally, what is the New Economic Geography? I do not know exactly who coined the term when. But, as is well-known, after a long period of neglect, a growing number of economists have recently become increasingly interested in the study of economic geography, the study of the location of economic activity. Among others, the recent work of Paul Krugman (1991a, 1991b) has triggered a new flow of interesting contributions to economic geography. The work represented by this new school of economists is generally called the New Economic Geography. Its hallmark is a general equilibrium approach to the modeling of endogenous agglomeration forces generated through the interaction of increasing returns, transport costs, and demand (as noted before). In other words, the defining issue of the New Economic Geography is how to explain the spatial concentration of economic activity in terms of a formal micro-economic theory of general equilibrium.

Historically speaking, however, the New Economic Geography represents a renewed interest in the “general theory of location and space-economy,” using the terminology of Isard (1956), or in short, the **general location theory**. According to Isard, a general location theory is supposed to embrace “the total spatial array of economic activities” in an economy. Or, if we use the words of Koopmans (1957), in

such a theory, the location of all economic activities and hence “the distribution itself is a variable.” (p.154).

Historically moving backward, the most recent wave in the general location theory is, of course, the New Economic Geography initiated early 1990s. As is well-known, its central topic has been how to explain the emergence of a core-periphery structure in a nationwide scale, or an international scale.

Before the New Economic Geography of 1990s, however, there appeared in early 1980s an equally successful, but less well-known, attempt of a general location theory in urban economics. As noted before, the most important limitation of monocentric urban models (a dual version of Thünen’s model) is their a priori assumption of the existence of the CBD itself. A number of urban economists, including myself, have tried to overcome this limitation, and successfully developed several prototypes of the so-called “Nonmonocentric Urban Models” in which the formation of the total spatial array of a metropolis (including the formation of a CBD or CBDs) has been endogenously determined.²² Often, the New Economic Geography (started in early 1990s) and Nonmonocentric Urban Models together is called “the New Economic Geography” (Baumont and Huriot, 2000). Hereon, we follow this broader definition of the New Economic Geography.

Going further back historically, there were several earlier attempts to develop a general location theory. A notable one is by Walter Isard himself in his seminal book, *Location and Space Economy* (1956). As indicated by its subtitle (i.e., *A General Theory Relating to Industrial Location, Market Areas, Land Use, Trade, and Urban Structure*), Isard’s book was written with the aim of nothing less than initiating the development of a general location theory. Actually, Isard’s attempt reflects an earlier idea of Ohlin (1993) who proposed the development of a “general localization

²²Early examples of Nonmonocentric Urban Models are Ogawa and Fujita(1980), Fujita and Ogawa(1982), and Fujita (1988). For a systematic exposition of such models, see, for example, Fujita (1990), Baumont and Huriot (2000), and Fujita and Thisse (2001, Chs. 6 and 7).

theory” by integrating trade theory and location theory.²³ However, by the reason to be explained later, such earlier attempts to develop a general location theory were, unfortunately, doomed to be incomplete.

For my discussion today, the most interesting attempt at developing a general location theory is the one by Thünen himself. Although Thünen did not, of course, use the term “general location theory”, I am sure that when he wrote the article on “The Order and Distribution of Towns in The Isolated State” (Chapter 4, Section 9, in the 1863 version of *The Isolated State*), he intended to explain (using Isard’s words) “the total spatial array of economic activities in the Isolated State. Indeed, Thünen’s attempt to develop a general location theory is not only the oldest one, but also the closest to the New Economic Geography for several reasons. First, when Krugman wrote a seminal paper, “Increasing Returns and Economic Geography,” in 1991, his central question was when the economy would become divided between a manufacturing “core” and an agricultural “periphery”. Aside from the treatment of space (a continuous space by Thünen and a discrete one by Krugman), the core-periphery structure of Krugman is essentially the same with the monocentric spatial structure of Thünen. Second, it should be clear from what I explained in the previous section that Thünen was attempting to explain the entire spatial structure of the Isolated State as the outcome of a process involving two opposing forces: **centripetal forces** which favor the agglomeration of industries at the Town (or, in the core), and centrifugal forces which work against industrial agglomeration. And, as I also explained in the previous section, Thünen’s two sets of forces are essentially the same with those of the core-periphery model of Krugman in 1991. Third, and finally, both Thünen and Krugman were always thinking the determination of the economy’s spatial structure in the framework of a general equilibrium theory. In particular, the determination of the equilibrium wage (at each location) for mobile workers was an

²³For a systematic discussion of early attempts for a general location theory, see Isard (1956, Ch.2). Refer also to Fujita (1999).

essential issue for both of them.²⁴

We can, therefore, conclude that if Thünen's original theory of monocentric spatial economy were combined with his another pioneering theory of industrial agglomeration such that a unified model of the Isolated State were developed, then it would become a typical general location model of New Economic Geography.

In other words, in retrospect, what the New Economic Geography has achieved is the unification of the two pioneering ideas of Thünen for the first time. Indeed, what Krugman did in his paper in 1991 is just such a unification of Thünen's two ideas using a two-region economy (but without knowing Thünen's idea on agglomeration economies). More surprisingly, what I and Krugman did in our paper, "When is the economy monocentric?: von Thünen and Chamberlin unified," in 1995 is exactly the unification of Thünen's two ideas in the original framework of the Isolated State itself. (again without previous knowledge of Thünen's work on agglomeration economies).

You may, then, naturally ask why Thünen did not develop such a unified model by himself?; why did it take so long to take such a (seemingly) small step? To prepare my answer, let me use a metaphor.

Since the birth of human being, almost every person had an eager dream of flying in the air, I guess. And, the basic mechanics of flying has been rather well-understood fairly long time ago. For example, if you see the drawings of "flying machines" by Leonardo da Vinci in the late 15th century, it is clear that he understood well the basic mechanics of flying in the air. But actually, it was only in 1903 that the Wright

²⁴It is also interesting to note that both Thünen and Krugman developed their spatial model by deviating almost in the same way from the then mainstream trade theory. In explaining his work on economic geography, Krugman (1991b,P.X) states as follows:

"As I worked on the subject, however, I found that my analysis was drifting further and further away from international economics I knew it. ...What I found myself gravitating toward was a style of model in which factors of production were perfectly mobile but in which there were costs to transporting goods. In other words, I found myself doing something closer to classical location theory than to international trade theory."

While, in characterizing Thünen's spatial theory, Samuelson (1983, p.1482) states as follows:

"Ricardian trade theory traditionally assumes zero factor mobility between countries or regions and 100 percent commodity mobility between countries or regions. Thünen's model works out the opposite case. Within a region, labor moves freely (on immobile land); goods move only at a cost. Where labor will locate was not question that trade theory considered, but Thünen did."

brothers finally succeeded in passing the test of flying more than 200 meters above ground. Why did it take so long? Because, human power itself was not sufficient for flying in the air, and hence we must await the invention of powerful combustion engines. Thus, it was just a matter of technologies, not of basic science.

Likewise, if we read the following sentences by Thünen (p.295) about the impact of the development of transport development on the distribution of towns in the Isolated State, then we can see that Thünen had actually a good unified-model in mind.

“It is worth noting that railway construction will rob of all their force the arguments against the development of the capital, and will strengthen those in favor of such growth. Thus we may say with certainty that railways will make an important contribution to the development of the large towns, and that, but for the fact that railways will promote also the prosperity of the rural districts surrounding the provincial towns, the latter would decay in consequence. ”

In fact, Thünen’s statement above coincides with one of the most important theoretical findings of the New Economic Geography: that is, (contrary to the intuitive belief of most people) the development of transport technology (at least in its initial phase) will strengthen the agglomeration of economic activities (operating under increasing returns) into the core region or in large cities.

But, then, why didn’t Thünen write down his unified model? He could not do so because he, like da Vinci, lacked a “combustion engine.” (To Be Continued)

5 Thünen and the future

Appendix: A unified model of the Isolated State